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ACCESS POINT TRANSMISSION OPTIMIZATIONS USING MACHINE LEARNING BASED TRAFFIC CLASSIFICATION

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ABSTRACT

Techniques are described herein for optimizing access point transmissions. According to these techniques, configuration, state, and tuning of an access point transmission scheduler are externalized to a network core (*e.g.*, a wireless LAN controller (WLC) or Dynamic Network Access Control (DNAC)) and a machine-learning system is used to classify wireless clients based on traffic analysis. The described techniques permit the use of fine-tuned configurations for each access point station and these configurations can be shared across all access points in the case of roaming.

DETAILED DESCRIPTION

In current deployments, transmit intelligence is located at the access points. In early 802.11 wireless standard releases, this arrangement did not cause a problem, however, since the release of later wireless standards, such as 802.11n, 802.11ac, and the upcoming 802.11ax, it is quite difficult for an access point to make the right decisions. For example, an access point has to decide the radio parameters (*e.g.* modulation and coding scheme (MCS)), the aggregation ratio (*i.e.*, wait a few slots to build bigger frames using Aggregate MAC Service Data Unit (A-MSDU) and Aggregate MAC Protocol Data Unit (A-MPDU)), choose between multi-user multiple input and multiple output (MU-MIMO) or single-user multiple input and multiple output (SU-MIMO) transmissions.

The problem with the current deployments is that these decisions cannot be correctly taken without a careful analysis. Usually these decisions are done based on a small backlog (*i.e.*, a few seconds) and without complex algorithms (*e.g.*, mainly due to storage and computation power limitations).

According to the techniques described herein, the configuration, state, and tuning of an access point transmission scheduler are externalized to a network core (*e.g.*, a wireless LAN controller (WLC) or Dynamic Network Access Control (DNAC)) and a machine-learning system is used to classify wireless clients based on traffic analysis. These techniques permit the use of fine-tuned configurations for each access point station, which configurations can be shared across all access points for roaming purposes. The solutions described herein are based on long-term data and can also help with understanding the impact of such RF optimization mechanisms.

With new technologies and techniques included in newer 802.11 wireless standards, such as 802.11ax, the right determination of tunable parameters such as Target Wake Time (TWT), Request to Send/Clear to Send (RTS/CTS), user grouping for MU-MIMO, etc. can become challenging for human users to determine.

The techniques described herein include the following steps:

1. Define client profiles (by classifying per application, device type, and RF characteristics)
2. Use the client profile to determine the right tunable parameters for transmission, such as RTS/CTS, power, TWT, etc.
3. Constantly evaluate the effect of the parameter on the client traffic (by analyzing the client performance in terms of traffic, 802.11v-learned environment, control messages, and telemetry-pushed client events)
4. Constantly adapt the tunable to optimize the performance (iteratively with step 3)
5. Suggest (*e.g.*, through 802.11r/v/k) which other access points can provide the same or better level of performance and support this client profile
6. Move such client profile from access point to access point as the client roams

As shown in Figure 1, some examples of wireless client categories include: live video streaming devices, voice devices (*e.g.*, voice over IP devices), web browsing devices, static devices.

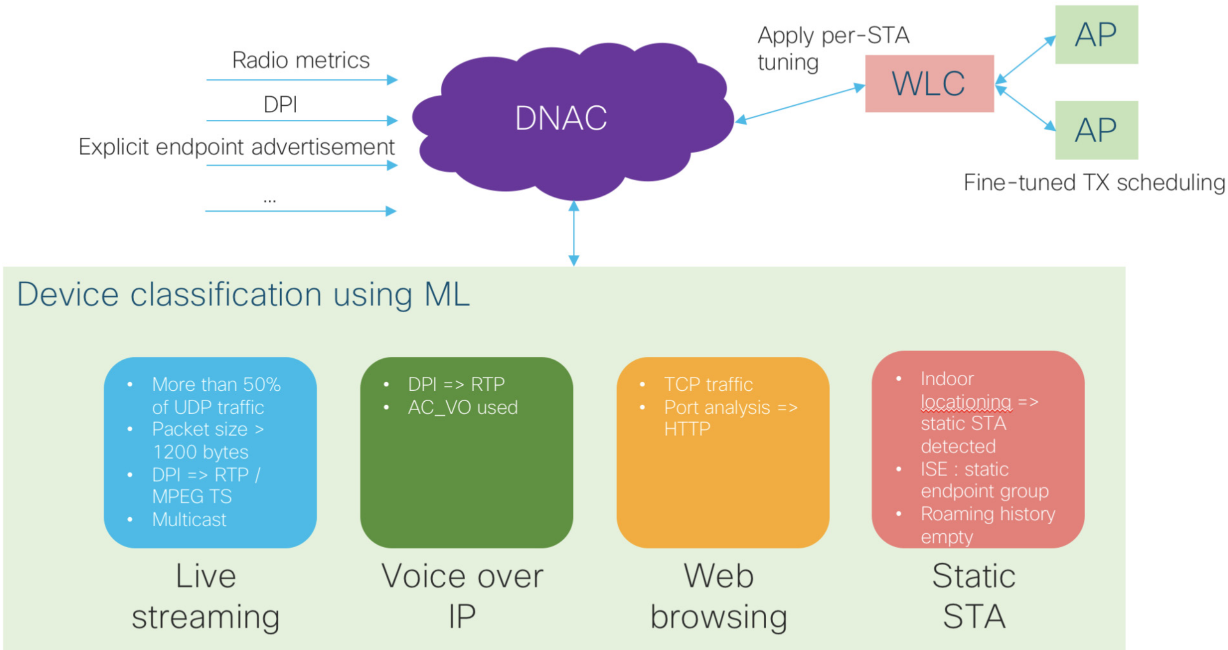

Figure 1

Examples of wireless configurations that can be improved by knowing which category a client is classified in include:

1. MU-MIMO: Users must be in groups to allow MU-MIMO transmission. The problem is that it is difficult to create groups (RF constraints, network usage, etc.). According to the techniques described herein, the system will be able to compute the most efficient groups by using RF state/configuration input and application awareness (*e.g.*, using Deep-Packet Inspection (DPI) or an explicit mechanism such as Fast Lane).
2. Deep-Packet Inspection (DPI): DPI can be used to glean the type of data and tune the scheduling. According to the techniques described herein, it will be possible to detect type of traffic to select MCS, aggregation configuration, etc. For example, a client that is using 90% of the medium to watch live video streaming cannot be put in a MU group, aggregation can be used but limited to avoid latency, MCS can be selected to force a stronger symbol protection to limit retransmissions, etc.

3. MU-MIMO: According to the techniques described herein, it will be possible to try to gather static stations in same MU groups to reduce steering matrix manipulation.
4. Airtime Fairness (ATF): According to the techniques described herein, it will be possible to turn on/off or change ATF configuration based on the current traffic analysis.

In summary, once clients are classified according to the techniques described herein, it is possible to choose: the right aggregation for each client (A-MSDU and A-MPDU thresholds), the right MCS (especially the coding scheme to be more error proof), the right MU grouping based on global information rather than local access point information, and the right TWT delay. These parameters may be associated with or assigned to a client as a profile no matter which access point the client is joined to or how many roaming access point connections the client makes, to provide a consistent and stable optimal experience to customers.